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ORIGINAL RESEARCH

COMPARISON OF HIP INTERNAL AND EXTERNAL ROTATION BETWEEN INTERCOLLEGIATE DISTANCE RUNNERS AND NON-RUNNING COLLEGE STUDENTS

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ABSTRACT

Background: The increased incidence of lower extremity injury in runners compared to the general population is well documented. The amount of passive hip rotation and the position of hip flexion or extension at which it occurs may be factors related to injury incidence.

Purpose: The purpose of the current study was to measure and compare hip rotation passive range of motion in male and female runners and non-runners at 0 and 90 degrees (°) of hip flexion.

Study Design: Descriptive Laboratory Study.

Methods: Eighteen Division II collegiate distance runners (9 female, 9 male, mean age =19.1, +/- 1.1 years) who had run for an average of 7.1 (SD=1.7) years participated in the study. Twenty non-runners (10 female, 10 male, mean age=19.6, +/- 1.1 years) from the same institution were also recruited. Passive hip internal rotation (IR) and external rotation (ER) were measured with a universal goniometer in 90° of hip flexion in a seated position, and in 0° of hip flexion in prone position.

Results: There was a significant difference in IR measured in 0° of hip flexion, between runners and non-runners ($F(1,37)=8.04$, $p=.007$). Additionally, the difference in IR between males (36.68 +/-9.19 degrees) and females (45.99 +/- 9.12) was significantly different ($F(1,37)=20.79$, $p=.001$). There were no other statistically significant differences in measurements between groups.

Conclusions: Collegiate runners had significantly greater passive hip IR when measured at 0° of hip flexion compared to the non-runners. Female runners had significantly greater passive hip IR compared to the male participants across both runners and non-runners.

Level of Evidence: 3

Key Words: Hip rotation, injury, lower extremity, running

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Acknowledgements
The authors would like to thank the runners and non-runners for their willingness to participate in this study.

The authors declare no conflicting or competing interests in relation to this article.

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INTRODUCTION

The increase in stride rate, stride frequency and center of gravity vertical displacement with running as compared to walking may increase the risk of injury.[1] Participation in running has continued to grow and has resulted in an overall increase in the number of runners injured.[2,3] Depending on injury definition and the length of follow-up period, the injury incidence among runners varies between 19-79%.[4]

During walking and running, the overall translation is along the sagittal plane, even though there are significant frontal and transverse plane contributions to this sagittal movement. In the weight-bearing phase, hip IR is functionally linked with hip adduction and hip flexion. During running, the increase in ground reaction forces due to vertical displacement of center of mass creates a significant increase in hip adduction and IR range of motion compared to walking.[5] Recently, the literature has identified risk factors for the increased incidence of patellofemoral knee pain proximally at the hip and trunk.[6,7] Recent research has linked aberrant frontal plane mechanics of the lower extremity, specifically excessive hip adduction, to increased knee injuries.[8] Relevant studies have also utilized proximal strengthening of hip abductors and external rotators in runners in order to decrease patellofemoral symptoms.[9] It is unclear if this strategy is successful based predominantly on the runner's foundational weakness of these muscles or excessive amounts of hip adduction and IR.[10] Therefore, excessive amounts of passive hip IR could result in range of motion that might need to be limited and/or controlled, eccentrically or isometrically via hip external rotators and abductors, possibly contributing to the risk of increased knee injuries.

The literature regarding assessment of and normative values for hip rotation are quite consistent.[11,12] The majority of standard examination normative values for passive hip IR, however, identify hip IR as being equal to or less than ER across all populations with hip ER in the range of 40-45°.[11] The majority of normative data for hip ER and IR has been gathered using the position of 90° of flexion of the hip joint in the sagittal plane, in a seated position.[11,12] Neither of the two previously published normative data sets nor the APTA (American Physical Therapy Association) Hip Pain and Mobility Deficits Clinical Practice Guidelines or American Academy Orthopedic Surgeons guidelines indicate a hip IR gender bias. There has been limited evidence of static lower limb alignment at knee and forefoot as well as range of motion measures at ankle being associated with injury in runners.[13]

The purpose of the current study was to measure and compare hip rotation passive range of motion in male and female runners and non-runners at 0° and 90° of hip flexion. The authors hypothesized that runners would have increased passive hip IR in 0° of hip flexion compared to non-runners and that female runners would have greater passive hip IR in 0° of hip flexion than male runners.

METHODS

Participants

Eighteen Division II collegiate distance runners (9 female, 9 male, mean age = 19.1, +/- 1.1 years) who had run for an average of 7.1 (SD = 1.7) years participated in the study (see Table 1). Subjects were a sample of convenience recruited from the cross country and track teams. To be included the runners had to compete in middle and/or long distance events, have trained for a minimum of three years (part or full time) and have trained for at least ten hours/week for the six months prior to the study. Runners were excluded from the study if they had an injury or pain that could be exacerbated by range of motion testing, could preclude them from running at the time of the range of motion testing, or precluded them from consistent training for the preceding twelve months.

An age and gender matched group of twenty non-runners (10 female, 10 male, mean age = 19.6, +/- 1.1 years), a sample of convenience, were recruited. Participants were healthy, recreationally active men

Table 1. *Demographic Data for Participants.*

	Runners	Non-Runners
Gender	F=9, M=9	F=10, M=10
Mean Age (years)	19.1 (+/- 1.1)	19.6 (+/- 1.1)
Mean Duration of Running (years)	7.1 (+/- 1.7)	N/A

and women aged 18-22 years majoring in health sciences at the same institution. Recreationally active for this comparison group was defined as participating in intramural sports on campus, fitness center based cardiovascular activity, or general strength training and flexibility. Non-runners were excluded if they had a history of lower extremity injury or pain, which was defined as having any previous hip, knee, foot or ankle injury in the prior twelve months that prevented them from participating in their chosen physical activity or if they ran more than one mile, three times per week in the past twelve months. Each participant was required to report to the Health Sciences Human Performance Laboratory on one occasion. An information sheet explaining the aims of the study was provided and an informed consent was signed. Approval for the study was obtained from the College's Institutional Review Board.

Data Collection

All participants completed a treadmill warm up that included walking for one minute at a comfortable speed followed by running at six miles per hour for five minutes. After the warm up, the participants sat on the edge of an exam table in a neutral lumbar spine position and passive hip IR and ER in 90° of hip flexion was measured with a flexible hand held Baseline 360 universal goniometer. The same two examiners measured all participants. Examiner one used both hands to stabilize the distal thigh at the table edge and examiner two measured range of motion by bringing the lower leg to the firm end point of both IR and ER (Figure 1). The participants then lay prone on table and passive hip IR and ER was measured with the same hand held universal goniometer. The thigh was carefully positioned in 0° of hip abduction or adduction, with the contralateral limb in approximately 20° of abduction. Examiner one stabilized the pelvis and examiner two measured range of motion by bringing the leg to a firm end point of both IR and ER (Figure 2). Each single measurement was taken on the left then the right for the odd numbered participants and right then left for the even numbered participants. A single measurement was chosen because it has been shown to be as reliable as the average of multiple measurements within the same session and is more consistent with clinical practice.[14]

Figure 1. *Position of hip ER and IR measured in siting at 90 degrees of hip flexion*
Examiner one used both hands to stabilize the distal thigh at the table edge and examiner two measured range of motion by bringing the lower leg to the firm end point of both IR and ER.

Figure 2. *Position of hip ER and IR measured in prone at 0 degrees of hip flexion.*
The participants were prone on table and passive hip IR and ER was measured with a flexible hand-held universal goniometer. The thigh was carefully positioned in 0 degrees of hip abduction/adduction, Examiner 1 stabilized the pelvis and Examiner 2 measured range of motion by bringing the leg to a firm end point of both IR and ER.

Data Analysis

Data were analyzed using SPSS (version 21.0). In order to examine the differences of hip rotation under different condition between runner and non-runners, a 2 (gender; male vs. female) X 2 (athlete vs. non-athlete) X 2 hip flexion degree (90 vs. 0 degree) X 2 side (left vs. right) X 2 rotation (IR vs. ER) repeated measures ANOVA was implemented. All alpha values were adjusted to 0.0125 for simple effect tests.

Table 2. *Hip rotation measurements (in degrees) at different flexion degree between runners and non-runners, presented as mean (SD).*

		Runners (n=18)	Non-runners (n=20)	F value	p value
FD 90°	IR	38.95 (7.00)	34.30 (5.61)	5.36	0.028
	ER	30.84 (4.78)	33.58 (3.84)	3.89	0.06
FD 0°	IR	50.82 (10.92)	42.58 (6.88)***	8.04	0.007
	ER	36.32 (7.83)	42.05 (6.50)	6.22	0.017

*** Indicates significant difference at the p<.0125 level (note: adjusted alpha value used to determine statistical differences was p< .0125). FD= degree of hip flexion during measurement

RESULTS

There was a significant interaction between runners and non-runners for degrees of hip flexion and hip rotation ($F(1,35) = 4.56$, $p = .039$,(Table 2). Simple effect tests showed the differences in IR between runners and non-runners in 90° of hip flexion was not significantly different ($F(1,37) = 5.36$, $p = 0.028$). In 90° of hip flexion, the difference in ER between runners and non-runners was not significantly different ($F(1,37) = 3.89$, $p = .061$). In 0° of hip flexion, the difference in IR between runners and non-runners was significantly different ($F(1,37) = 8.04$, $p = .007$), however, the ER differences between runners and non-runners was not significantly different ($F(1,37) = 6.22$, $p = 0.017$).

There was also a significant interaction between hip rotation and gender (Figure 3) ($F(1, 35) = 9.55$, $p = .003$). Simple effect tests showed that the difference of IR between males and females was significantly different ($F(1,37) = 20.79$, $p = 0.00001$) with males demonstrating a mean of 36.68°($SD = 9.19$) and females demonstrating a mean of 45.99° ($SD = 9.12$). The difference in ER between males and females was not significantly different ($F(1,37) = 0$, $p = .75$ with males demonstrating a mean of, 35.75° ($SD = 7.79$) and females demonstrating a mean of 35.75° ($SD = 7.46$). Finally, there was not a significant main effect for ($F(1, 35) = 1.79$, $p = 0.19$) indicating that there were no differences between left and right legs for IR or ER in either 0° or 90° of hip flexion for both runners and non-runners.

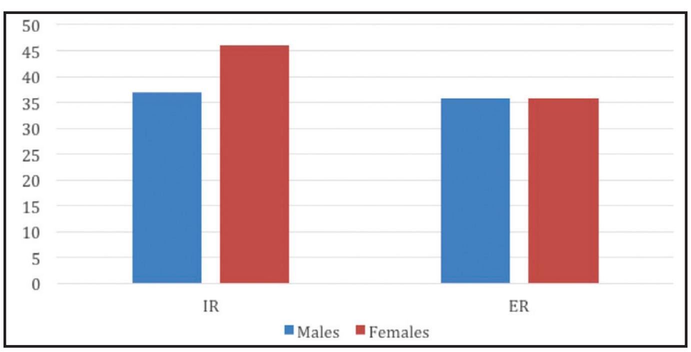

Figure 3. *Internal and external hip rotation comparison between males and females.*

DISCUSSION

The results of this pilot study demonstrated that collegiate runners have significantly greater hip IR at 0° of hip flexion compared to the non-runners. Prior research has identified a hip IR difference of 8° or less as a threshold to separate injured from uninjured athletes.[15,8] Specifically, Li found a subset of baseball players with hip injuries compared to the no injury group had decreased passive hip IR on the right IR 29° versus 35°.[8] Sousa, found runners with patellofemoral pain demonstrated significantly greater average dynamic hip internal rotation (8.2° versus 0.3°).[15] In addition to this statistical difference it is the authors' opinion that an 8° difference in hip rotation is clinically significant as well.

The mean standard deviation of repeated ROM measurement of extremity joints taken by one examiner using a universal goniometer has been found to range from 4 to 5°.[16,17] Therefore, to show improvement or worsening of joint motion measured by the same examiner, a difference of 5° (±1°) to 10° (±2°) is necessary. Therefore, the 8° of difference in IR measurements between runners and non-runners, while statistically significant, also falls within the range that clinicians should notice and is likely clinically significant.

Current literature focuses on the role of increased dynamic hip IR with weight-bearing in running as being potentially causative of distal symptoms and able to be successfully treated with hip abduction and ER strengthening.[9,10] The current findings of the presence of increased passive hip IR in non-weight bearing in runners may indicate that greater available hip dynamic IR may need to be controlled by dynamic proximal stabilizers in weight bearing. Though the process of clinically-based video assessment of running continues to improve with regard to time required and cost, it still exceeds the time and fiscal constraints of many clinicians and settings, not to mention patient confidentiality. In settings where these hurdles can be overcome, the current findings may be a valuable adjunct to allow clinicians to focus their video assessment on hip internal rotation as well as internal rotation eccentric control. In this study, the statistically significant finding of greater passive hip IR in the sample of runners compared to non-runners should inform clinicians to consider this simple, clinically perceptible measurement, in combination with available complimentary assessments, including video, when treating the running population.

An unexpected finding that was not part of the original purpose of the study was that the historical notion that hip ER is greater than or equal to IR is not supported when runners were measured at 0˚ of hip flexion. The two most commonly utilized textbooks for the education of athletic trainers and physical therapists in the clinical skill of goniometry do not identify the need for measuring hip rotation solely in 0˚ of hip flexion or at 0˚ and 90˚ of hip flexion and none indicate that greater hip IR may occur in any position.[11,12] Both references places normal ER at 45°- 50° with IR equal to or slightly less at 45°. What has been considered to be normal hip rotation should be reassessed in this specific population and testing motion within the functional range that it is pertinent to the chosen activity should be considered. The hip position during running is much closer to 0˚ of hip flexion than 90˚. The finding that there was no difference in rotation between runners and non-runners at 90˚ of hip flexion, the traditional and "convenient" position to test these motions, indicates that a statistically and possibly clinically significant difference in hip rotation may be missed by measuring hip rotation at 90˚ of flexion versus 0˚. Finally, the lack of any difference right to left is consistent with no significant side dominance typical of distance runners overall.

The second hypothesis that female runners would have greater passive hip IR in 0˚ of hip flexion than male runners was supported as significantly greater passive hip IR was seen in female compared to male participants across both runners and non-runners. Previous literature has reported mixed findings on the gender differences. An additional goniometric reference, though offering data on a gender bias covering the 18-22 age range regarding hip IR, does not offer this gender bias for hip IR in their normative data section for clinicians.[18] However, anecdotally, most clinicians would indicate that females have greater passive hip IR and some researchers have agreed.[19] There is current literature linking dynamic knee valgus, which is mechanically linked to hip IR range of motion, as greater in females than males upon jump landing.[20] The findings from the current study provide additional insight on the gender differences in passive hip IR and ER measurements between runners and non- runners.

Both of the hypotheses being supported is consistent with the patterns seen in the literature to date regarding an increased risk of injury being greater at the knee for runners versus non-runners and for females versus males.[21,22] Prior research has demonstrated increased dynamic hip adduction and IR in females while running being correlated to patellofemoral injury.[9] Our study did not directly attempt to investigate running related injury nor the risk of it. Further investigation may support a correlation between these mentioned dynamic measures, lower extremity injury and simple goniometric measurements of passive hip IR as prior studies have linked passive and active hip rotation variations to low back pain, shoulder and elbow injuries.[23,24]

LIMITATIONS

Some limitations of the current study include a relatively low sample size and the convenience sample of both runners and non-runners, a single examiner, and a single simple measure. As the non-runners were students majoring in health sciences, they may have been more physically active than the general population. This may limit the measurement differences between runners and non-runners. The choice of a single examiner was intentional to maximize the reliability during this initial investigation of a single measurement of joint passive range of motion. Clinicians should consider that the researchers found disparate results in passive hip rotation ROM from past literature when evaluating these subjects and that future evaluation is warranted. Future studies should include a larger sample size and a more representative sample of participants, multiple examiners and the measurement of both active and passive range of motion.

CONCLUSIONS

The results of this study suggest that there may be differences in passive hip IR between males and females and between runners and non-runners, when measured in 0 degrees of hip flexion (in prone). Based on these results, clinicians may consider that passive hip IR can be dependent upon the angle of hip flexion at which it is measured. The traditional assumption that hip IR is less than or equal to hip ER is not consistent with the current findings. The results of this study warrant the consideration of assessment of hip IR in 0° of hip flexion as a clinical tool when working with females, both runners and those in the general population.

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